Collecting and Interpreting Temporal Data in an Expert System

William J. Long[1], Hamish Fraser[1,2], Shapur Naimi[2], James Stahl[2]

[1]MIT Lab for Computer Science, Cambridge, MA,

[2]Tufts-New England Medical Center, Boston, MA

Background. Last year we reported on the Web interface for the Heart Disease Program (HDP)[2], a program to diagnose the range of conditions that cause hemodynamic dysfunction[1,3]. The use of the HTML entry forms by physicians has given us new insight into the problems of entering and interpreting data. The most challenging data, both for entry and for interpretation, is temporal information. For example, the temporal pattern of anginal chest pain is crucial for distinguishing among stable angina, unstable angina, and myocardial infarction. To enable the user to describe the temporal details of angina, questions are presented asking for the *total duration of symptoms, episode length, frequency, temporal pattern*, and whether *currently in pain*. This allows the user to enter a description such as:

- anginal chest pain on exertion for 1 week, lasting minutes, occurring often, worsening for 1 week, but not currently in pain.

Given this, the HDP generates a representation of the finding with a time interval of [1 week to now] and the property *worsening*. This finding then has a high probability of being caused by unstable angina and is an important part of the diagnostic hypotheses generated by the HDP.

Temporal information. Several kinds of temporal information are needed for the diagnostic reasoning of the HDP. The most obvious is the temporal extent of the finding. Findings present for a long time rule out causes present for a shorter time. The existence of past events are also important. A previous MI often has long term effects on the heart. Aortic stenosis, even though corrected by a valve replacement, often leaves permanent ventricular hypertrophy. The order of findings also provides important clues to the causal order of the disease states. The distinguishing patterns of the findings, such as acute onset (or single event), progressive, chronic stable, and episodic also provide important clues to their causes. Diseases such as stable and unstable angina are distinguished primarily by these patterns.

Temporal menus. The menus needed to provide this information about the findings must be carefully designed to be unambiguous, encourage entry of the important characteristics, and minimize entry time.

While some findings need only a time (lab tests) or a duration (medications). The symptoms (angina) need up to five menu questions to gather sufficient information. These may include associations with other findings (nausea with chest pain) that can change the probable causes. The menu is necessarily a compromise between the distinctions understood by the program and the language of the physician.

Challenges for interpretation. Even with a carefully designed menu, physicians sometimes differ in their characterization of temporal characteristics. The interpretation of the findings is not always easy. Patterns may be manifest either as a property of a finding or as multiple findings. E.g., exertional dyspnea with more recent rest dyspnea may be described as progressive dyspnea. Often the user leaves the details of the findings underspecified and the HDP must fill them in appropriately or occasionally modify details that are inconsistent. When this happens, the program adds a note to the input description printed with the differential diagnosis to alert the user.

Conclusion. The interface has proven useful for collecting an adequate description of the patient for the 130 cases that have been entered by physicians and diagnosed by HDP so far in our current evaluation.

References

1. Long WJ, Naimi S, Criscitiello MG. Evaluation of a New Method for Cardiovascular Reasoning. Journal of the American Medical Informatics Association. 1994;1:127-141.
2. W. J. Long, H. Fraser, and S. Naimi, Web Interface for the Heart Disease Program, In: Cimino, JJ, ed. Symposium on Computer Applications in Medical Care. Washington, DC, 1996 :762.
3. W. J. Long, H. Fraser, and S. Naimi, Reasoning Requirements for Diagnosis of Heart Disease, Artificial Intelligence in Med. (to appear).